40 Hickory Ridge Rd.
Conway, MA 01341
July 12, 2006

Minerals Management Service
U.S. Department of Interior

Re: Cape Wind Environmental Impact Statement

To Whom It May Concern:

My name is James F. Manwell and I am writing to offer my comments on the Draft Environmental Statement for the Cape Wind Project. I am a Professor and the Director of the Renewable Energy Research Laboratory in the Department of Mechanical and Industrial Engineering and at the University of Massachusetts in Amherst, but am writing this letter as a private citizen. I have worked in the field of renewable energy for more than 25 years and am particularly familiar with offshore wind energy; presently I serve on behalf of the United States on the International Electrotechnical Commission's Technical Committee (IEC TC88 WG3) that is developing design standards for offshore wind turbines. I also have followed Cape Wind project closely and served as a member of the Peer Review Committee that provided a Technical Review of Preliminary Screening Criteria for the Cape Wind EIS. I have no financial connection with the Cape Wind Project.

I urge you to approve the draft Environmental Impact Statement that has already been completed for the project, and allow the project to move ahead as expeditiously as possible. That said, I would like to offer a few additional comments. These comments have to do with the scope of the draft EIS and the Alternatives Analysis.

First of all, it is apparent to everyone who deals with power generation, that there will always be some impacts associated with the production of electricity. What is most striking about the draft EIS is how little adverse impact is actually anticipated. I would like to turn instead to why the Cape Wind project is so important, and why it should be supported, in spite of whatever adverse impacts there are that can not be eliminated.

The Cape Wind project is important because it represents a first and very meaningful step to commercially develop a potentially very significant new source of energy in the United States, namely that of offshore winds.

The issue of environmental impact has been at the heart of the debate over the Cape Wind project. The proponents emphasize that project will displace generation from other, less benign sources of power. The opponents focus on the impact on the immediate aesthetic and recreational attributes of Nantucket Sound. If those were the only issues, they would still be of interest. They both side-step the larger issues, however. Those issues have to do with what our long term energy supply will look like and what the larger effect on our environment will be as we adapt to an inevitably changing world. In this context, the Cape Wind project is particularly important in the launching of a new renewable energy based economy. Such an economy can help forestall and reverse the very serious environmental damage and social upheaval that current one, based on fossil fuels, has engendered.

The potential contribution of wind energy to a reduction in greenhouse gases has been widely noted. I believe it is worthwhile to consider some other benefits as well. In doing so, it is appropriate to step back and first consider what the options are for supplying energy to our society.

The realistic options can basically be divided into four categories: (1) fossil fuels, (2) nuclear power, (3) geothermal and (4) renewable energy sources. Energy efficiency can reduce the need for a certain fraction of input energy, and is certainly crucial element in any sensible energy future, but it can never eliminate the need for primary sources. Other "energy sources" sometimes mentioned include hydrogen, fuel cells, and pumped storage. Hydrogen itself does not occur in sufficient quantities in nature to be considered a fuel; rather it is produced from another source, and should be viewed as an energy storage medium, not a source in itself. Fuel cells are devices for producing electricity from hydrogen (or from other gases, such as natural gas, if a reformer is added to the system). Thus fuel cells are a technology, not an energy source. Pumped storage is, as the name implies, a means of storing energy, and does not result in any net production of energy, and so is also not an energy source.

The following is a very brief overview of some of the main options.

The fossil fuels are primarily petroleum, natural gas, and coal. Regardless of their environmental attributes, the reserves of fossil fuels are quite limited. As summarized by Bernard Bulkin of Chief Scientist of British Petroleum in "The Future of Today's Energy Sources" (this is an article in "Sustainability and Environmental Impact of Renewable Energy Resources," Issue #19 in Issues in Environmental Science and Technology, published by the Royal Society of Chemistry in 2003, edited by R. E. Heister and R. M. Harrison), at today's consumption levels, the world's oil reserves are sufficient for approximately 40 years, natural gas reserves for 60 years, and coal for 200 years. Compared to the length of human history, and even to this history of the United States, those are very short periods. In addition, in lieu of better alternatives, it can be expected that there will be a tendency to turn to coal, as the other sources become depleted and correspondingly more expensive. This will result in an increase in carbon dioxide production per unit of energy output. This is reverse of the direction that needs to be taken to forestall climate change. Furthermore, carbon sequestration, which is sometimes seen as a solution to the CO_2 problem, appears to be quite problematic at the present time.

The nuclear options include the conventional fission of uranium, breeder reactors, or fusion. As described by David Elliot, Professor of Technology Policy and Director of the Energy and Environment Research Unit at the UK's Open University, in "Sustainable Energy: Choices, Problems and Opportunities," (this is also an article in "Sustainability and Environmental Impact of Renewable Energy Resources") conventional fission accounts for approximately 6% of the world's primary energy. It has been estimated that readily mined uranium would last a few hundred years, at current consumption rates. Significantly increasing the percentage of the world's primary energy from nuclear power would result in a correspondingly shorter time for which conventional uranium reserves would last. For example, increasing the fraction to 30% would result in only 40 years supply remaining. It is possible that more diffuse sources of uranium, such as low grade ore or sea water, could be exploited, but that would come at higher cost. In addition, increased use of nuclear power faces many obstacles, ranging from public opposition to the problems of disposing of radioactive waste and guarding it from terrorists. Breeder reactors can greatly extend the life of the uranium fuel supply, but questions of production of plutonium and the relation between breeder reactors and the proliferation of nuclear weapons have not been resolved. Practical fusion energy is still just a dream at this point.

The summaries above did not consider the “conventional” environmental impacts of, for example, mining, transporting, and refining, all of which can be quite substantial. For some sense of the very real environmental impact of mountain top removal coal mining, for example, I would turn your attention to recently released book, Lost Mountain, by Eric Reece. (As that book makes clear, the devastation resulting from mountain top removal coal mining - for obtaining coal used for electricity production - dwarfs any conceivable environmental impact from wind turbines.) The summaries above also omitted the geopolitical issues associated with ensuring the availability of energy supplies from foreign suppliers. These are also quite significant.

Geothermal can be an attractive source of energy in some locations, but compared with the world’s energy requirement, the potential is small.

Within the category of renewable energy sources, the most promising are direct solar energy conversion, wind energy, hydropower, tidal energy, wave energy, and biomass, and ocean thermal energy conversion. All of these depend ultimately on the sun or, in the case of tides, the moon, and so will persist far into the foreseeable future. Direct solar energy conversion is very appealing, and will no doubt be used increasingly in the future. At the present time, however, it is still relatively expensive, and in any case the number of hours in the year during which electricity can be produced from a solar array in New England will always be limited. Hydropower has been utilized for many years in the region, but the number of new sites that can be developed is also limited, and hydropower development has its own environmental issues. Wave energy has some potential for use in New England, but the wave resource is considered fairly marginal, and the technology is still not commercially available. Biomass certainly has some potential in New England. It must be recalled, however, that the overall conversion efficiency of solar energy to energy stored in biomass is quite low (on the order of a few percent), so the amount of biomass that can be harvested sustainably is also limited. In addition, although there is no net production of carbon dioxide from the combustion of sustainably harvested biomass, there can be other harmful emissions which need to be controlled. Ocean thermal energy conversion (which depends on the temperature difference between waters near the surface and those of the ocean depths) has no real potential in New England, because the surface waters are so cold. The tidal resource is also limited in New England, and it is certain that there would be many environmental issues to resolve before any large tidal power facility could be sited in the region.

The one remaining energy source is the wind. There is little doubt that there is a significant wind energy resource in New England, both on land and offshore. So far, however, there have been relatively few modern wind turbines installed in the region. Obstacles to wind energy utilization are a mixture of social, economic, and technical. It may be presumed that there will slowly begin to be more wind turbines installed on land as the obstacles are addressed. Because of various constraints, however, it is doubtful that there will be large scale development of on shore wind farms in Massachusetts, at least, in the near future (although there will probably be more and more turbines installed singly, as in Hull, or in smaller clusters, such as in Princeton). This will be true unless something dramatic happens to our energy supply. This observation is consistent with the Alternatives Analysis of the EIS.

It is the offshore region which has the greatest potential, both in the near term and the long term. As is fairly widely known, the world's first serious proposals for offshore wind projects were developed in the 1970's by Prof. William Heronemus, a naval architect and professor at the University of Massachusetts. In spite of that, it was in Europe that the first offshore wind projects were actually built. Heronemus' concepts were more visionary, in that he proposed floating wind plants in relatively deep water. His concepts may yet prove to be harbingers of a realizable future technology. The European method has been more incremental and more readily realizable, however. This method began by using wind turbines designed for land, but installed on offshore support structures designed by ocean engineers. By taking advantage of the offshore experience in Europe, Cape Wind will able to begin U.S. endeavors into this technology much more quickly than would otherwise be possible.

It is quite understandable that Cape Wind proposes its project in the relatively shallow and protected waters of Nantucket Sound. The wave climate there is less severe than it is in the more open waters to the east. Therefore, extreme waves and wave induced fatigue should be of less concern than would otherwise be the case. There should be less down time and access for maintenance will be possible over more of the year.

Offshore wind turbine design is continuing to evolve, and offshore turbines are beginning to diverge from their land based counterparts. It is to be expected that it will eventually be possible to take offshore wind turbines into progressively deeper water, farther from shore. The future offshore wind turbines will probably have even larger rotors, or perhaps multiple rotors. They will be placed on specially built bottom mounted support structures, or perhaps even floating or semi-submersible supports. It is expected that much of the experience of offshore oil and gas industry will be of relevance to developing this new technology. The economics of this new technology will have to be considered very carefully, however. The costs of the support structure will surely increase as the depths get greater, but there will be no increase in energy production. Going farther from shore should increase energy production somewhat due the higher winds, but costs will also be higher due to the more severe wave climate, longer transmission lines, and more difficult access.

The possibility of eventually going further and deeper will be enhanced by the experience that will be gained with the turbines in Nantucket Sound. It should also be noted that, although there is much benefit to be had by learning from offshore wind experience in Europe, there is no substitute for experience here as well. The northeast coast of the United States is not the same as either the Baltic or the North Sea. It is prudent that the first projects be relatively close to shore, and in relatively shallow water before moving further out. Nantucket Sound is a good place to begin.

Some of the larger issues we all must face are discussed in a recent book by Jared Diamond, entitled <u>Collapse: How Societies Choose to Fail or Succeed</u> (Viking Press), and they are of relevance to the Cape Wind debate. The book examines in considerable detail a number of societies that have already collapsed, ranging from the Norse of Greenland to the Mayans of Central America; some that are in danger; and some that have survived, in spite of great difficulties, for a long time. The common thread is that a few social and environmental factors and the society's response to them can greatly influence the society's ability to survive. Adaptability is seen as the key to survival, whereas inflexibility at addressing the root cause of the problem can lead to eventual catastrophe. Diamond speculates that the Mayan civilization perished because their elites retreated from the effects of the damage they were causing to their environment until it was too late. On the other hand, he believes that the Dutch have survived because their elites recognized that they were in the "same boat" as everyone else (i.e. below sea level), so in order to save themselves they needed to take an active role in learning to adapt to their environment.

The most serious environmental impacts, in the broadest sense, that our nation must face are those associated with energy supply and its side effects. Failure to address such serious issues proactively and comprehensively can be disastrous, as Diamond has shown. The options for a safe, sustainable, and climate neutral energy supply are limited, as discussed above. Wind energy is one of the most promising, and New England's offshore wind resource appears to be as good as any. It needs to be taken seriously.

Today in the United States many people feel that "someone else" can deal with the problems of climate change and resource depletion. Residents of the Alaskan island of Shishmaref, however, are already finding that their land is disappearing due to erosion, and the cause of that erosion has been directly linked to climate change. The residents of Cape Cod and the islands who live within sight of the proposed Cape Wind project may find themselves faced with a similar quandary, since that area, too, may directly experience the effects of climate change (such as severe storms, bank erosion, and flooding) before many other locations do. They can ignore the real problems, and hope that someone else deals with them, like the Mayans, or they can take an active role in addressing them, like the Dutch. As the representative of the larger society, the Minerals Management Service has the opportunity to help make the best choice for all of us. It is time to approve the draft Environmental Impact Statement and let the Cape Wind project move forward.

Sincerely,

James F. Manwell

James F. Manwell, Ph.D.